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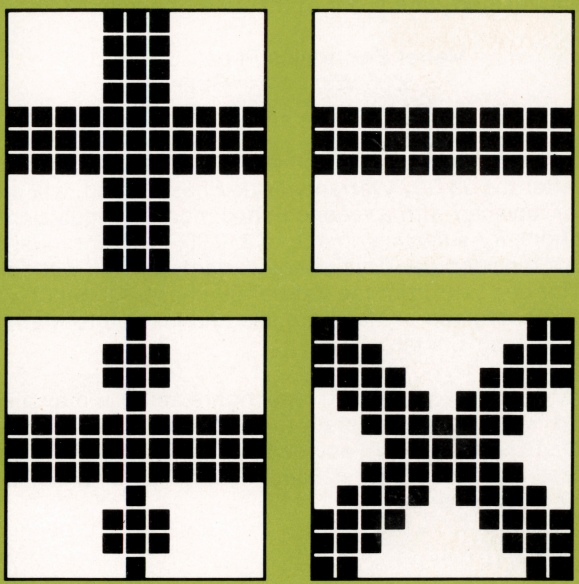
THE Children's Discovery System™



Activity Book

DISCOVERIES IN™ MATH I
Learning Fun Module

Use this learning fun module with
The Children's Discovery System™ Computer

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THE CHILDREN'S DISCOVERY SYSTEM™ LEARNING FUN MODULES

90 DAY LIMITED WARRANTY

Mattel Toys warrants to the original consumer purchaser of any of its Electronic Toys that the product will be free of defects in material or workmanship for 90 days from the date of purchase.

During the 90-day Warranty Period, the product will either be repaired or it will be replaced with a reconditioned model of equivalent quality (at our option) without charge to the purchaser, when returned either to the dealer with proof of the date of purchase, or when returned prepaid and insured, with proof of the date of purchase, to

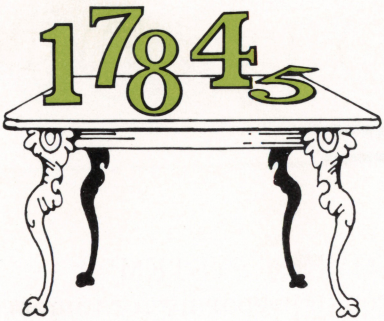
Mattel Electronics Repair Center
5000 West 147th Street
Hawthorne, California 90250

Units returned without proof of the date of purchase, or units returned after the 90-Day Warranty Period has expired, will either be repaired or replaced with a reconditioned model of equivalent quality (at our option), for a service charge of $10.00. Payment must be made by check or money order. This out-of-warranty service will only be available for one year from the date of purchase. All out-of-warranty units must be returned postage prepaid and insured to Mattel Electronics Repair Center.

This warranty gives you specific legal rights and you may also have other rights which vary from state to state. This warranty does not cover damage resulting from accident, unreasonable use, neglect, unauthorized service or other causes not arising out of defects in material or workmanship.

IF YOU HAVE ANY QUESTIONS OR PROBLEMS REGARDING THE USE OF, **THE CHILDREN'S DISCOVERY SYSTEM™** OR YOUR LEARNING FUN MODULES, CALL THIS TOLL-FREE NUMBER:

(800) 421-2887



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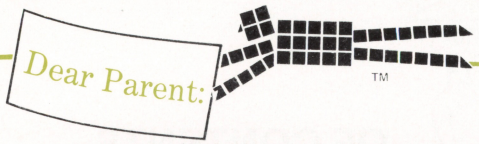


THE CHILDREN'S DISCOVERY SYSTEM™ is designed to assist children in preparing for tomorrow's requirements while satisfying today's needs.

Major education associations are emphasizing that the mathematics educational goal in the 1980's is to make it possible for all children to use mathematics effectively in the solution of everyday problems; to be able to think mathematically; and to feel comfortable with mathematics as a valuable tool that can help them in every aspect of their lives.

Discoveries in™ Math I Learning Fun Module has been designed to help children gain mastery of and fluency with basic number facts and basic mathematical operations in conjunction with their daily needs. It is also designed to challenge your child and to make the learning process interesting and fun. The activities that have been programmed into the cartridge and created for this book are based on well-documented effective teaching strategies used by educators. The range of activities which includes three levels of difficulty will make the Discoveries In™ Math I Learning Fun Module useful for the beginner as well as the older child who may need to brush up on skills.

The Activities Book is a valuable source of ideas on how to extend the use of the computer. And the more creative your child can be in using the computer, the more he or she will enjoy it.

The computer itself should provide a good source of motivation for your child to become a better mathematician. As a small microcomputer, it can engage your child in a continuing dialogue that challenges and stimulates. Whatever level of difficulty your child

wishes to undertake, the computer will always respond to your child's answers, acknowledging right and wrong answers in a positive way.

Discoveries in™ Math I Learning Fun Module can perform in four ways:

1. It can do calculations using any or all of the mathematical operations: addition, subtraction, multiplication and division.
2. It provides drill in whatever basic number facts your child would like to practice at the level of difficulty desired (easy, medium, or hard).
3. It gives a computation quiz in any of the four operations at any of the three levels of difficulty.
4. It can do conversions from U.S. units of measurement to Metric units; or from Metric units to U.S. units.

Your child can use the Discoveries in™ Math I Learning Fun Module the same way as the basic computer: alone, with a friend, or with you. The Children's Discovery System™ computer is a total environment for learning and fun. With the addition of each learning module, the growth possibilities are limitless. And your child will be on the way to preparation for the future and a new literacy. Computer literacy.

We welcome you to this exciting computer world.

Sincerely,

Raymond P. Wagner

Raymond P. Wagner
President

Dear Boys and Girls:

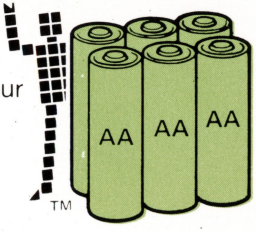
Where in the world would we be without math? We wouldn't know how old we are. We wouldn't know how far away our school is. We wouldn't know how tall we are. We wouldn't know much at all. That's where the world would be without math. Math is counting and using numbers in a lot of different ways. We can add, subtract, multiply and divide—math makes sense if we only give it a chance. It gives us answers to problems. Sometimes easy and sometimes hard. And with your own computer, you can solve many math questions. Questions and problems you find in real life. You can figure out your allowance and learn to budget. You can master metric. And best of all, you'll learn just how much fun math can be. So let's get started and see how math adds up!

Hi, remember me? I'm Cursor the Great.™ I'm the computer man who is made up of many little black computer squares. I'll be around again to point out special things to you in this Activity Book.

We're going to have lots of mathematics fun together. So let's get started!

INSIDE THE CARTON YOU WILL FIND:

"REMEMBER...to keep fresh batteries in your computer. It uses six AA alkaline batteries. If you need to put new batteries in, check the front of your Computer Activity Book for directions. (Any time your computer starts showing strange displays or not doing what it's supposed to do, it probably needs fresh batteries.")



CARTRIDGES NEED GOOD CARE, TOO!

Your Discoveries In™ Math I cartridge has some very delicate electronic parts inside. Because of this, it needs some extra care.

Don't leave it in direct sunlight or anywhere else where it will get very hot (120°F or hotter).

Don't let it get very cold either (35°F or colder).

Don't get your cartridge wet or dirty.

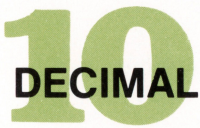
When you're finished using a cartridge, TAKE IT OUT OF YOUR COMPUTER. Put it away with your Activity Book and Keyboard Overlay in the storage box.

Do not try to plug your cartridge into any other computer. Do not try to plug any other type of cartridge into YOUR computer.

Take care of your DISCOVERIES IN™ MATH I cartridge and it will work for a long, long time.

SOME MATHEMATICAL WORDS TO KNOW

DIGIT. The most common number system used in the world today has ten symbols. These symbols are 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9. They are called **digits.** There are ten digits or symbols. The name of this system is the decimal numeral system.



The name of the numeral system we use. It is based on ten digits. These digits only go up to the number 9, so we place them side by side to represent numbers larger than 9. Each position in which we place a digit has a value. These positions are named **ones,** ten times "ones" or **tens,** ten times "tens" or **hundreds,** ten times "hundreds" or **thousands,** ten times "thousands" or **ten-thousands,** and so on. A decimal system moves along by ten; that is, the value of each position is ten times the value of the position on its right or one-tenth of the position on its left. The digit that we place in a particular position tells us how many of that value we have. **Example:** if we write the number 345, we have 3 hundreds, 4 tens and 5 ones. We say three hundred, forty five.

This looks just like a period and is placed to the left of a decimal fraction (a fraction is part of a whole number) to tell you how big or small a number is. **Example:** 1.35 or 3.24. Decimal fractions are also based on ten, but the positions on the right side of the decimal point have different values than the positions on the left side. **Example:** if we write the number 345.4, we have three hundred, forty five **and** four **tenths.** 345.26 is three hundred forty five and twenty six **hundredths.**

NEGATIVE NUMBERS. This is a number you get when you subtract a larger number from a smaller number.

Example:
$$\begin{array}{r} 5 \\ -7 \\ \hline -2 \end{array}$$

AVERAGING. The numbered result you get when you divide the sum of two or more quantities by the number of quantities. **Example:** 4 students took a test. Their scores are as follows:

85 72 96 83

What is their average test score? Add all the scores together.
Divide by 4 (for the 4 students) **336 ÷ 4 = 84**
The average test score is 84.

METRIC. A system of measurement that is used in many countries of the world is called the metric system. The U.S. is switching to this system, too. Like our decimal system, it uses ten as its base. Your computer will help you get started using the metric system.

PROBABILITY. A big word telling you there's a chance for a certain thing to happen a certain percent of the time. **For example:** If you toss a penny, what is the chance (or probability) that you will toss heads? Try it. Toss a penny ten times. Keep a chart like this one. Put a mark by the correct column every time you toss.

HEADS	TAILS
~~////~~ /	////

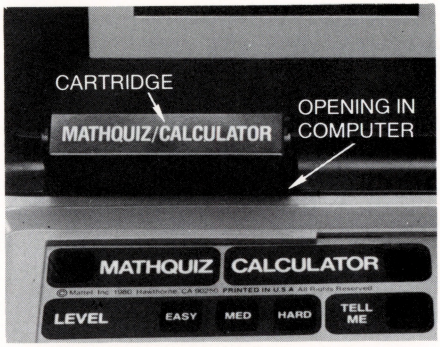
In this case we tossed a coin ten times. We tossed heads six times and tails four times. The more times you toss the coin, the closer you come to the 50/50 chance of tossing heads and the 50/50 chance of tossing tails. That's probability.

ROUNDING OFF DECIMALS. A way of making a long, complicated number simpler and less exact. Say you have the number 1.36598 and you only want to know the decimal number to the nearest **tenth** (the first position after the decimal point). Go on to the next number right—in this case the 6. If that number is under 5, drop it and all the other numbers to its right. If that number is 5 or over, add 1 to the number in the tenths place. So 1.36598 becomes 1.4 when you round it off.

LET'S GET STARTED!

OFF **1. Make sure your computer is turned OFF.**

2. PUT THE CARTRIDGE INTO THE COMPUTER. *Push it in as far as it will go.* The side that says Math Quiz/Calculator should be facing UP.



When you want to take a cartridge out, TURN OFF THE COMPUTER and pull the cartridge straight out.

3. PUT THE OVERLAY OVER THE KEYBOARD. Your learning fun module comes with a thin, plastic sheet that fits over the computer keyboard. This is called an OVERLAY. It is printed on one side only.

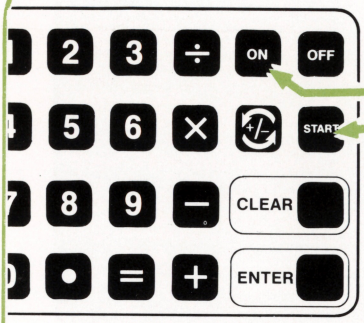
Find the LONG LIP that runs all the way around the keyboard, except for a top and bottom space in the middle of the keyboard. Start in this middle space and slip the LEFT side of the overlay UNDER the LEFT TOP and LEFT BOTTOM LIPS. Slide the overlay all the way under the LEFT END LIP, as far as it will go.

Now slip the RIGHT side of the overlay under the RIGHT TOP and RIGHT BOTTOM LIPS. You will have to make a loop in the overlay to do this. (See the picture.) BE CAREFUL NOT TO CREASE THE OVERLAY. Slide the right side of the overlay all the way under the RIGHT END LIP, as far as it will go.

Make sure the overlay is securely under the lip, all the way around the keyboard, except in the middle. This overlay tells you which keys to use in the Discoveries ™® Math cartridge.

Each cartridge that you use will have its own overlay.

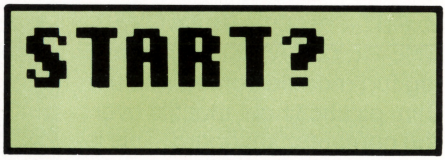
MATHQUIZ OR



ON KEY

START KEY

When your computer comes on, you will hear TWO MUSICAL NOTES and see the question **START?** on the screen.



PRESS THE START KEY until you hear a SHORT BEEP. (You will hear a beep like this whenever you press any key. The beep tells you that the computer knows you have pressed that key.) You will then hear FOUR MUSICAL NOTES and see MATH I on the screen. Cursor the Great™ will run across the screen, from left to right, erasing the title MATH I as he runs across.

CHOOSE A MODE

When Cursor the Great™ runs off the screen, you will hear more MUSICAL NOTES and see the question MODE? on the screen. This question means, "How do you want to use your Discoveries In™ Math I cartridge?"

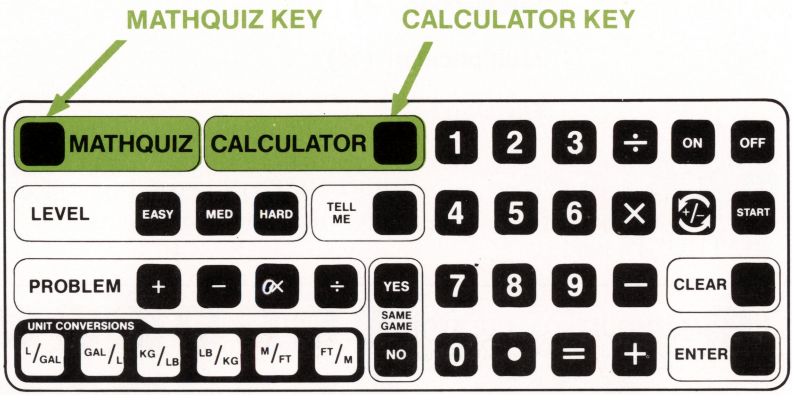
There are TWO MODES in the Discoveries in Math I cartridge—two ways you can use it.

1. You can use it as a calculator, to add, subtract, multiply, divide and convert measurements from U.S. to Metric and Metric to U.S. (See page 28 for conversion instructions.)

CALCULATOR

2. You can play a 10-Question MATHQUIZ. (See page 40 for instructions.)

When you see the question **MODE?** press either the CALCULATOR Key or the MATHQUIZ Key—depending on what you want to do.



The next 27 pages will tell you how to use the CALCULATOR MODE. If you want the MATHQUIZ mode, go directly to page 40.

REMEMBER: IN EITHER MODE, IF YOU DON'T PRESS ANY KEY ON YOUR COMPUTER FOR ABOUT 2½ MINUTES, IT WILL SHUT OFF TO SAVE THE BATTERIES. TO USE IT AGAIN, PRESS THE **ON** KEY.

CALCULATOR MODE

Any time you press the CALCULATOR Key (even if you are in MATHQUIZ mode), the screen will go BLANK, except for a 0 (zero) in the top right corner. This zero tells you that the computer is ready to act as a calculator.

With your Discoveries In™ Math I Calculator, you can do all four arithmetic operations. The four arithmetic operations are:

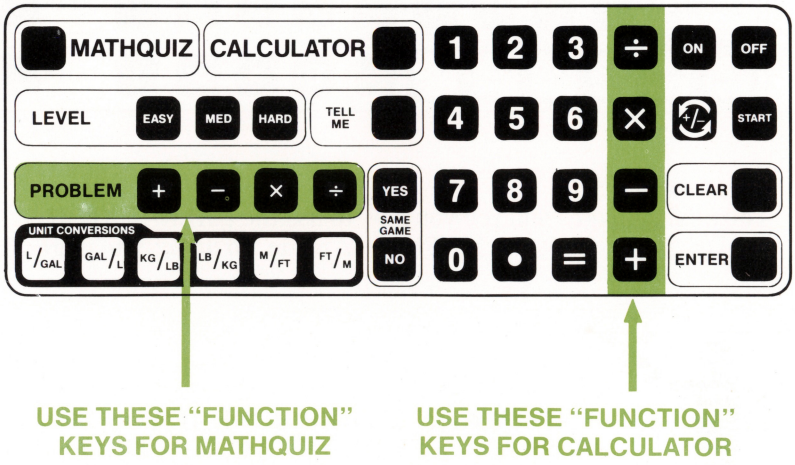
Addition (+)

Subtraction (−)

Multiplication (×)

Division (÷)

When you use your computer as a calculator, use the WHITE +, −, ×, ÷ keys. (These are called FUNCTION keys.) Do NOT use the yellow function keys—they only work when you are in MATHQUIZ mode.



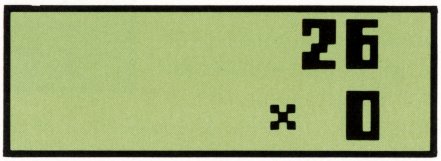
Numbers appear on the screen in two rows—top and bottom. No more than 8 DIGITS will fit on a row. (A DIGIT is any single number. 2 and 6 are both digits in the number 26.)

HOW TO + − × ÷

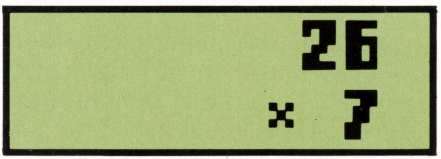
Follow these steps. We'll do a sample problem (26 × 7):

1. Press the NUMBER KEY(S) for the first number in your problem. It will appear on the screen like this:

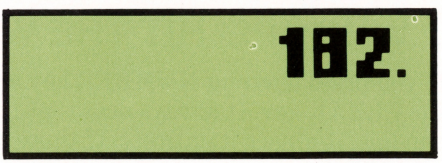
2. Press the WHITE FUNCTION KEY you want: +, −, ×, or ÷ You will see this:



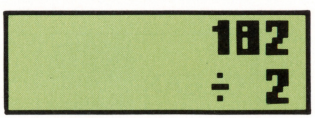
3. Press the NUMBER KEY(S) for the second number in your problem. You will see it like this:



4. Last of all, press the = KEY. Your problem will disappear from the screen and you will hear a SHORT MUSICAL TUNE. The answer to your problem will automatically appear on the top row of the screen, like this:



You can continue to do as many more problems as you wish. Add, subtract, multiply or divide the last number that appears on the screen.



Equals:

COMPUTER NUMBERS HAVE RULES TOO!

1. Neither the first nor second number in your problem can be more than 7 digits long. (A negative sign does not count as a digit.)

If the first or second number is bigger than it is supposed to be, the computer will give a WARNING BUZZ and simply not print the extra digits.

2. The answer to any problem you give the computer cannot be over 8 digits. If an answer is over 8 digits long, the computer will erase the bottom line of numbers and print ERROR on it. It will then give a WARNING BUZZ and return the screen to the starting point.

3. You can do calculations with decimal numbers, but you can only have a maximum of 7 digits on the screen. This includes numbers to the left and right of the period. The period in a decimal does NOT count as one of the 7 digits. To enter a decimal number, say 7.25, press 7, period, 2 and 5.

WHOOPS! HIT THE WRONG KEY?

If you press a wrong NUMBER key and want to change it, use the CLEAR key. It always erases everything on a line. If there's one line, it erases it entirely. If there are two lines, it erases the second line.

If you press a wrong FUNCTION key and want to change it BEFORE you type in the second number, just press the new function key you want.

After you type in the second number, use the CLEAR key to erase the second number.

If you press the CLEAR key TWICE, the entire screen will be erased and will return to the starting point.

ABOUT RIGHT ANSWERS
(AND ALMOST RIGHT ANSWERS)

Most people think that when you do mathematics, you are always trying to figure out exactly correct answers. However, that's not so. It is true that at times, like in school, you do want an exactly correct answer. But very often when you use mathematics in your daily life, you do not want to figure out an exactly correct answer. You want to make a good guess (called an estimate) that will give you an almost correct answer which is good enough. For many common mathematical problems, an almost right answer is good enough and more useful than an exactly right answer.

To be good at mathematics you need to develop three kinds of skills:

1. You need to have **skill at calculating exactly** right answers when they are needed.

2. You need **skill at making good guesses** (estimates) of almost right answers when almost right answers are good enough.

3. You need **skill at knowing** when a right answer is best and when an almost right answer is best.

Your computer is a tool that can help you calculate exactly right answers. It can also help you improve your ability to make good guesses. When you do a problem with your computer, first try to guess what the answer will be. Even if you have no idea what the answer is, try by making a guess. In the beginning you may find that your guesses are not very good at all. That's O.K. You can't expect to be very good when you haven't had much practice. With practice, you will find that your ability to make good guesses will improve greatly.

Getting better at making good guesses also comes with knowing some "basic facts" so well that you are absolutely sure of them. The more of these basic facts you know for sure, the better you will be at making good guesses. Among the facts that most of us have to know are:

Some simple addition facts like:

$1 + 1 = 2$ $2 + 2 = 4$ $4 + 4 = 8$

Some simple subtraction facts like

$8 - 4 = 4$ $4 - 2 = 2$ $2 - 1 = 1$

Some simple multiplication facts like

$1 \times 1 = 1$ $2 \times 2 = 4$ $4 \times 4 = 16$

Some simple division facts like

$16 \div 4 = 4$ $4 \div 2 = 2$ $2 \div 2 = 1$

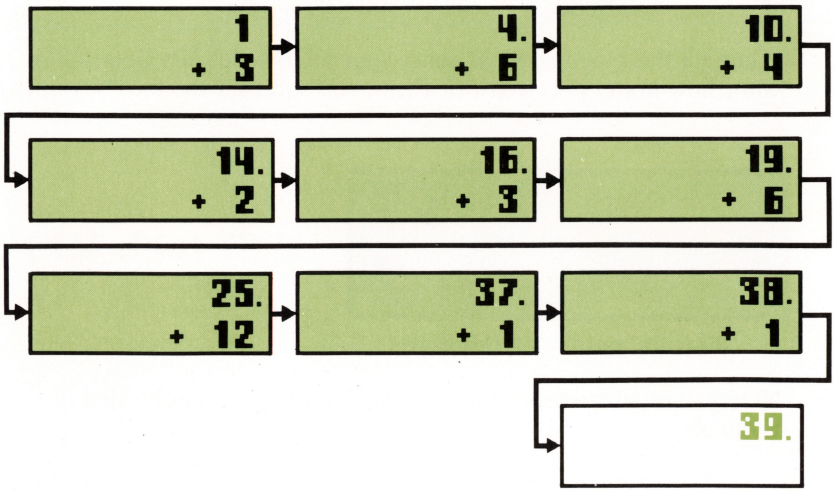
Keep working on your estimating as you practice real math facts and problems. Try doing problems in your head with a friend. See who can be the first to get the right answer or who can come closest with an estimate. If your friend seems much better at doing a certain kind of problem in his or her head than you, ask how he or she does it. People often develop excellent "tricks" for solving problems in their heads. Someone else's trick might work for you. You'll see how easy it becomes and how much fun it is!

LET'S TACKLE SOME PROBLEMS!

Mr. Goodfellow owns a pet store. Suppose he asked you to help him run his pet store. One of your jobs is to keep track of how many pets are in the store. The first morning on the job before the store opens, Mr. Goodfellow asks you to add up all the pets. You count and list the following on paper.

1	cat	3	canaries
3	kittens	6	parakeets
6	white mice	12	goldfish
4	gerbils	1	garden snake
2	guinea pigs	1	mynah bird

To find the total number of pets, you do the following calculations:



1 + 3 + 6 + 4 + 2 + 3 + 6 + 12 + 1 + 1 = 39

There are 39 animals in the store. You may want to write your answers on paper so you will remember the numbers if you need to use them later.

After the store opens, the following pets are sold:

- An old woman buys two kittens for her two grandchildren.
- A teacher buys all the gerbils for her third grade class.
- The hotel manager buys half the goldfish for the fish tank in his hotel.
- Mr. Roberts buys a pair of white mice for his son's birthday.

When all these people have gone, your job is to let Mr. Goodfellow know how many pets are left. First, you subtract the two kittens:

```
  39
-  2
```

= 37 (pets left)

39 (total pets) — 2 (kittens)

Now you must subtract the gerbils. The teacher bought all 4 of them, so:

```
  37
-  4
```

= 33 (pets left)

37 (pets left) — 4 (gerbils)

How many goldfish did the hotel manager take? There were twelve to start with and he took half. You can use the computer. One half is the same as dividing by two:

That means the hotel manager bought 6 goldfish. So:

33 (pets left) – 6 (goldfish) = 27 (pets left)

Finally, Mr. Roberts bought a pair of white mice. A pair is two. So:

27 (pets left) – 2 (white mice) = 25 (pets left)

You can tell Mr. Goodfellow that there are 25 pets left in the store.

Mr. Goodfellow says: "We're getting pretty low on pets. We'd better order some more from the pet supplier." Mr. Goodfellow phones the pet supplier.

A few hours later, the new pets arrive.

2 boxes with 3 kittens in each box
1 box with 4 guinea pigs
1 box with 6 gerbils
3 bags with 7 goldfish in each bag
1 cage with a parrot

Mr. Goodfellow asks you to calculate a new total for the number of pets in the store. You may want to write your answers on paper so you will remember the numbers if you need to use them later.

First, the kittens:

2 (boxes) × 3 (kittens per box) = 6 (kittens)

25 (pets left) + 6 (kittens) = 31 (pets now in store)

Add 4 guinea pigs:

31 (pets in store) + 4 (guinea pigs) = 35 (pets now in store)

Add the gerbils:

35 (pets in store) + 6 (gerbils) = 41 (pets now in store)

Find the total number of new goldfish:

3 (bags) × 7 (goldfish per bag) = 21 (goldfish)

41 (pets in store) + 21 (goldfish) = 62 (pets now in store)

Finally, you add the 1 parrot:

62 (pets in store) + 1 (parrot) = 63 (pets now in store)

You report to Mr. Goodfellow that he now has 63 pets in his store. He says, "Gee, it feels like it's getting a bit crowded in here. Can you tell me how many more pets we have now than when we opened the store this morning?" You say, "Sure I can, Mr. Goodfellow, that's easy."

You remember that there were 39 pets in the store when the store opened, and you know that there are 63 pets now. So, you calculate:

63 (pets now) − 39 (pets at opening) = 24 (more pets now than at opening)

"Thanks a lot. You've been a big help," says Mr. Goodfellow.

In helping Mr. Goodfellow, you have used all four operations that are possible on your computer. And you have seen how quickly and easily your computer can help you with any kind of calculation.

WHAT ARE AVERAGING AND ROUNDING ALL ABOUT?

Let's do problems that are a bit more difficult and find out.

Suppose Mr. Goodfellow wanted to place an order for gerbil food. He checked his records. He found that he had either sold or used the following bags of food in the past six months.

January—23 bags	**March—13 bags**	**May—19 bags**
February—18 bags	**April—26 bags**	**June—20 bags**

Mr. Goodfellow would like you to find out how many bags of food on the average he is selling or using per month. (See page 10 for an explanation of averaging and rounding.)

First, you have to find out the total number of bags of food sold or used during six months. Add the numbers above and you get 119 bags. Then, to find the average number of bags for **each** month, divide by the number of months, which is six:

119 (bags) ÷ 6 (months) = 19.833333 (bags per month)

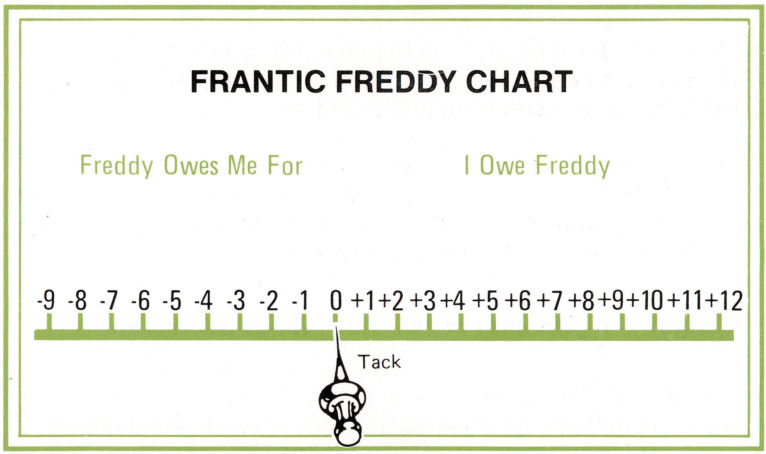
The answer of 19.833333 that you get by dividing is very exact because the division has been carried out to six decimal places. (See page 9 for an explanation of decimals.) Sometimes you need an answer that is that exact. But Mr. Goodfellow only wanted to know **about** how many bags per month (not exactly how many). The answer Mr. Goodfellow wanted is to the nearest bag. Since 19.833333 is closer to 20 than it is to 19, the best answer for Mr. Goodfellow is 20. This is called rounding off to the next highest number.

Mr. Goodfellow wants to order enough bags of food for three months. Figure the amount he needs by using the average number of bags per month which you just calculated.

20 (bags per month) × 3 (months) = 60 (bags to order)

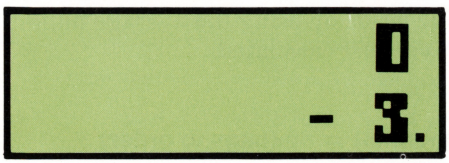
THE FRANTIC FREDDY PROBLEM...

You can also help Mr. Goodfellow with the Frantic Freddy problem. Frantic Freddy always buys his gerbil food from Mr. Goodfellow, but he's always in such a rush that he either forgets to pay for the bags of food he takes, or he pays for some of the bags of food and forgets to take them with him. So Mr. Goodfellow figured out a way to keep track of how many bags of food he owed Freddy or how many bags of food Freddy hadn't paid for.



Mr. Goodfellow puts a tack on the right number on the line.

To begin with Freddy and Mr. Goodfellow are even. The tack is at 0. The first week Freddy comes in and takes three bags of food without paying. To figure out where the tack should go, do the following calculation on the computer.



– 3 is called a negative number. (Remember the explanation of negative numbers on page 10.)

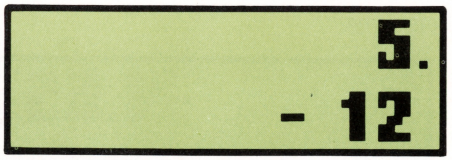
OR NUMBERS CAN BE NEGATIVE!

Put the tack at -3. The next time Freddy comes in, he pays for 8 bags of food, but forgets to take any. Continue with your calculation:

Screen already shows -3 on the top line.
Now press + and 8. Then = to get 5.

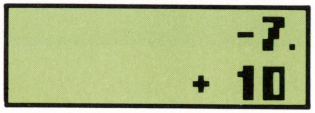
$-3 + 8 = 5$ (which is $+5$, of course). So the tack now gets put at $+5$.

The next time Freddy comes in, he takes 12 bags without paying for them. So you calculate:



And the tack gets placed at -7. The next time Freddy comes in, he does something really strange. He leaves enough money for 10 bags, but he takes 4 bags. Now where should the tack go?

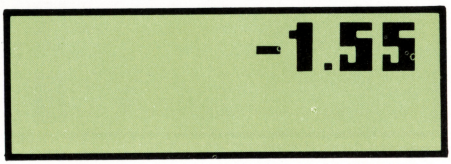
Using your computer, you might do the following:



So, -1 is your answer. The tack should go at -1.

Your computer can do more difficult problems with negative numbers. You've spent most of your allowance, and you need a new tire for your bicycle. You borrow $1.55 from your brother to buy the tire. You now owe your brother $1.55. In other words, you are in debt in the amount of $1.55. On the computer you can show this by using a negative number.

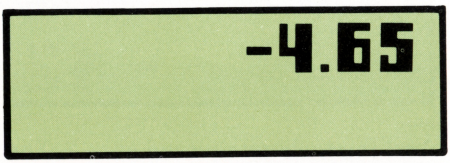
Enter 1.55. To make this amount a negative number, press +/- key. The screen now reads −1.55, which is the amount you are in debt. (The dollar sign does not show on your screen.)



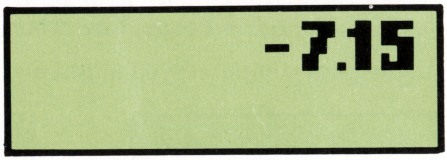
Now suppose you have some bad luck. Another tire on your bicycle blows out, and this time you have to borrow $3.10 from your brother and $2.50 from your mother. How can you show your total debt?

First add the amounts you borrowed:

1. Press + key, then 3.10, then +/- key to make it negative. Now press the = key. You will see −4.65 on the top line.



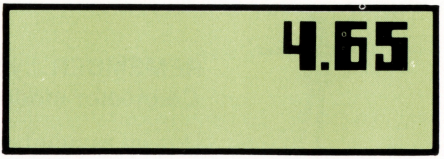
2. Press + key, then 2.50, then +/- key to make it negative. Press = key to get −7.15 on the top line.



This tells you that you are $7.15 in debt.

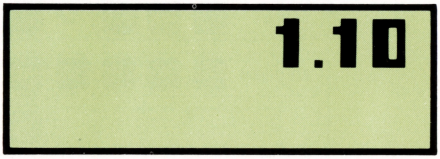
Fortunately, your next door neighbor hires you to do some work in his yard. In two days you make $8.25. You decide to pay your brother first. You owe him a total of $4.65 ($1.55 + $3.10). You pay him, and subtract that amount from your total debt. (7.15 − 4.65)

Enter 7.15.



Press the subtract key [−] key. Enter 4.65. When you press the [=] key, you will find that your debt is now reduced to $2.50. (You see this as 2.5 on your screen. The computer does not show extra 0's when using decimals.)

Now you decide to pay your mother. The computer already shows 2.5 on the top line. Press the subtract [−] key, followed by 2.50. Press [=] key. You have now cleared up your debts, so the balance on the screen is 0.



However, since you made more money ($8.25) than you owed ($7.15), your computer should show that you still have some money left over. To find out how much you have left, enter the amount you made (8.25) and then subtract the amount you paid (7.15). You will find you have $1.10 left. Congratulations!

UNDERSTANDING NEGATIVES?

If you had some trouble with understanding this, don't be surprised. Negative numbers can be troublesome. Try asking your mother or father what happens if they make a mistake and write checks for more money than they have in their checking account. Maybe they would like to borrow your computer to balance their checkbook!

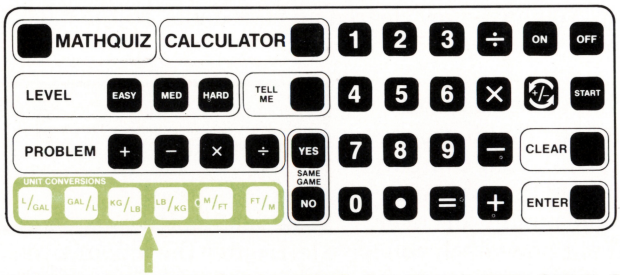
Later in this book, you will find games and activities that make use of the calculating capacities of your computer. But remember to have it around any time you need to do some calculations quickly and accurately.

CHANGING TO METRIC

REMEMBER...your computer should be in Calculator mode.

Do you remember what metric means? It is an easy way of measuring, that many countries use today. Look back at the section "SOME MATHEMATICAL WORDS TO KNOW" for a more complete explanation (page 10).

Your computer can help you change from the U.S. kind of measurement to the metric kind of measurement. This is called making a conversion. You don't have to remember formulas...just press one of the **CONVERSION** KEYS. Look at these keys in the picture.



FIND THESE CONVERSION KEYS ON THE LEFT SIDE OF THE KEYBOARD, AT THE BOTTOM.

L/GAL Changes **liters** to **gallons,** when you know the number of liters.

GAL/L Changes **gallons** to **liters,** when you know the number of gallons.

KG/LB Changes **kilograms** to **pounds,** when you know the number of kilograms.

LB/KG Changes **pounds** to **kilograms,** when you know the number of pounds.

M/FT Changes **meters** to **feet,** when you know the number of meters.

FT/M Changes **feet** to **meters,** when you know the number of feet.

IS EASY!

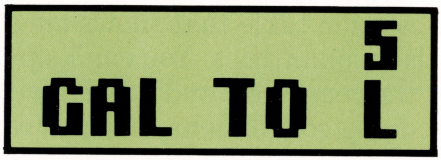
LET'S DO A SAMPLE "CONVERSION"

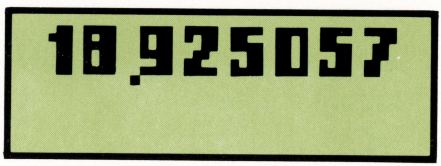
You have 5 **gallons** of water. You want to know how many **liters** of water you have.

1. Press the number key **5**

2. Press the **GAL/L** (gallons to liters) KEY, because you want to change 5 gallons to some number of liters.

The screen will first show





Then you will hear a THINKING TUNE and the screen will change to show the NUMBER OF LITERS, in this case 18.925057. You can round this number off to 18.9. (See page 10 for an explanation of rounding numbers.)

IN GENERAL, WHEN YOU WANT TO CONVERT ONE TYPE OF MEASUREMENT TO ANOTHER...

- Press the NUMBER KEY for the measurement you know. In our example that number was 5, for 5 gallons.
- Press the CONVERSION KEY that starts with the measurement you know. In our example, this was the GAL/L key, because gallons was the measurement you knew.
- The answer will appear on the top line of the screen.

THINK METRIC!

Mr. Goodfellow read in the newspaper that soon everyone in the U.S. will be using metric measurements. Because he wants to get a head start, he has decided that in his pet store he is going to "think metric."

You can help Mr. Goodfellow think metric because you can do certain basic conversions automatically with your computer.

"First," said Mr. Goodfellow, "I want to create a conversion table that shows me some of the basic conversion quantities. You can help me make this table using the computer, and it will give you some practice in doing conversions. Are you ready? Let's give it a try."

VOLUME

Gallons	Liters	Liters	Gallons
1	_____	1	_____
5	_____	5	_____
10	_____	10	_____
25	_____	25	_____
50	_____	50	_____
100	_____	100	_____

IT MAKES SENSE!

USE A PENCIL SO YOU CAN ERASE.

LENGTH

Feet	Meters	Meters	Feet
1	_____	1	_____
5	_____	5	_____
10	_____	10	_____
25	_____	25	_____
50	_____	50	_____
100	_____	100	_____

WEIGHT

Pounds	Kilograms	Kilograms	Pounds
1	_____	1	_____
5	_____	5	_____
10	_____	10	_____
25	_____	25	_____
50	_____	50	_____
100	_____	100	_____

Check your conversions with the answers on page 66.

CONVERSION TABLES

You may need to make conversions that are not on your computer before you can solve certain problems. These conversion tables will help you.

TABLE I U.S. TO METRIC

U.S. Unit	U.S. Equivalent	Metric Equivalent
Linear Measurement:		
1 inch	0.083 foot	2.54 centimeters
1 foot	12 inches	0.3048 meter
1 yard	3 feet	0.9144 meter
1 mile	5,280 feet	1.609 kilometers
Liquid Measurement:		
1 fluid ounce	8 fluid drams	29.573 milliliters
1 pint	16 fluid ounces	0.473 liters
1 quart	2 pints	0.946 liters
1 gallon	4 quarts	3.784 liters
Dry Measurement:		
1 pint	½ quart	0.551 liter
1 quart	2 pints	1.101 liters
1 peck	8 quarts	8.810 liters
1 bushel	4 pecks	35.238 liters

TABLE II METRIC TO U.S.

Metric Unit	Metric Equivalent	U.S. Equivalent
Linear Measurement:		
1 millimeter	0.001 meter	0.03937 inches
1 centimeter	10 millimeters	0.3937 inches
1 decimeter	10 centimeters	3.937 inches
1 meter	10 decimeters	39.37 inches 3.2808 feet
1 kilometer	1000 meters	3,280.8 feet 0.621 miles
Liquid Measurement:		
1 milliliter	0.001 liters	0.0344 fluid ounce
1 liter	1000 milliliters	1.057 quarts
Weight Measurement:		
1 milligram	0.001 grams	0.0154 grains
1 gram	1000 milligrams	0.035274 ounce
1 kilogram	1000 grams	35.274 ounces 2.205 pounds

HELPFUL HINTS! When good guesses are enough!

1 meter is a little over a yard long	(length)
1 kilometer is about ⅝ mile	(length)
1 kilogram is a little over 2 pounds	(weight)
1 liter is a little over 1 quart	(volume)

Now that you've had a bit of exercise in using your computer to make conversions, you should be ready to give Mr. Goodfellow a hand with metric problems.

"Today," says Mr. Goodfellow, "I buy gasoline for my pet store truck by the gallon. Soon I will have to buy it by the liter. The gas tank of the truck holds 17 gallons. Can you tell me how many liters it holds?"

Here's how to easily solve this problem for Mr. Goodfellow:

1. **Press CALCULATOR MODE.**
2. **Type 17 on screen.**
3. **Then press GALLONS TO LITERS** GAL/L **key.**

You reply to Mr. Goodfellow that his tank will hold 64.345193 liters. "Thanks," says Mr. Goodfellow. "You were surely able to figure that out quickly. But your answer is a bit more exact than I need. I'll just round it off to 64.3 liters, which is close enough.

"While we're converting gallons to liters, we should change the signs on all the 20 gallon fish tanks. Can you tell me what the new signs should say?"

Using your computer the same way you did before, you are quickly able to tell Mr. Goodfellow, "Well, the exact answer is 75.700227 liters. But I think that 75.7 liters is probably close enough."

"Good for you," says Mr. Goodfellow. "I'm glad you are learning how to round off those exact numbers. And let's remember to change the signs tomorrow."

"Now I have another problem for you," says Mr. Goodfellow. "The other day I was measuring the floor of the pet store because I am thinking of buying a new floor covering. I measured the floor and I found that it is 34 feet long and 27 feet wide. Can you tell me what the dimensions are in meters?"

Again, you can solve this problem for Mr. Goodfellow easily on your computer:

1. **Enter 27 on the screen.**
2. **Press FEET TO METERS FT/M key.**
   Your answer should be 8.2296 meters.
3. **Enter 34 on the screen.**
4. **Press FEET TO METERS FT/M key.**
   Your answer should be 10.3632 meters.

Round both of these answers to the nearest tenth of a meter, so you have only 1 digit on the right side of the period. Tell Mr. Goodfellow, "I figure the floor of the pet store to measure 8.2 meters by 10.4 meters."

"Now," says Mr. Goodfellow, "I have one more problem I would like you to help me with. All of my bags of gerbil food are now weighed by the pound, but I would like to sell them by the kilogram. I have 2-pound, 3-pound, and 8-pound bags. Can you figure out for me what I should mark these bags in kilograms?"

Here's how you use your computer to find the answers for Mr. Goodfellow. Be sure to clear your screen.

1. **Enter 2 on the screen.**
2. **Press the LB/KG button that changes pounds to kilograms.**
3. **Write down the result, clear the screen, and then do the same for 3 and 8. You then show Mr. Goodfellow your results:**

Pounds	Kilograms	Rounded Off
2	0.9072	0.9
3	1.3608	1.4
8	3.6288	3.6

"Thank you. That's excellent," says Mr. Goodfellow. "It won't take us long to change the weight markings on the bags."

READY FOR TOUGHIES? HERE ARE MORE COMPLICATED CONVERSIONS

"Many times," said Mr. Goodfellow, "conversions are not quite as easy as the ones we just did. They may require several steps to get to the answer, and you may need to know some additional conversion factors to help you. Let me give you an example."

What if I wanted to know how many liters are in this 32 ounce bottle of dog shampoo? I know that the computer can convert gallons to liters. So, in order to use it to make the conversion, I would first have to change 32 ounces into gallons. This takes several calculations.

YOU WILL NEED TO KNOW:

16 ounces = 1 pint
2 pints = 1 quart
4 quarts = 1 gallon

1. First convert ounces to pints
Remember: 16 ounces = 1 pint
Calculation: 32 ounces ÷ 16 ounces/pint = 2 pints

"So now we have pints," said Mr. Goodfellow. "Next, we need to get from pints to gallons." Here's what we do:

2. Convert pints to quarts
Remember: 2 pints = 1 quart
Calculation: 2 pints ÷ 2 pints/quart = 1 quart

3. Convert quarts to gallons
Remember: 4 quarts = 1 gallon
Calculation: 1 quart ÷ 4 quarts/gallon = 0.25 gallons

"Now, you can use your computer to convert 0.25 gallons to liters."

4. Convert gallons to liters
Calculation: Enter 0.25 on the screen
Push GALLONS TO LITERS
GAL/L key.

If you carry out this conversion, your answer should be 0.9462528 liters, or about 0.9 liters if you round it off.

"That sounds about right to me," said Mr. Goodfellow. "I remember that one liter is about the same amount as one quart. When we found that our 32 ounces was a quart, I knew we would have about 1 liter when we figured it out.

"Now that you know how to do conversions that take several steps, let's see if you can do a couple more. I'll show you the steps and what you need to know. You see if you can figure them out."

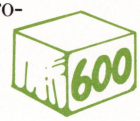
"Last Tuesday I drove six miles to deliver that baby kitten for Judy's birthday. Can you help me figure out how many kilometers I drove?"

1. Convert miles to feet
Remember: 1 mile = 5,280 feet
Calculation: 6 miles × 5,280 feet/mile = 31,680 feet

2. Convert feet to meters
The number of feet you got in step 1 is still on the screen. Push FEET TO METERS FT/M key.

3. Convert meters to kilometers
Remember: 1 kilometer = 1000 meters
Calculation: Number of meters on screen ÷ 1000 meters = _____ kilometers.

"You followed that very well," said Mr. Goodfellow. "Let's see if you can do one more with me. Last week a box of frozen brine shrimp arrived for me to sell as tropical fish food. The box weighed 600 grams. Can you help me figure out how many ounces of brine shrimp I have?"



CLEAR **CLEAR THE SCREEN**

1. Convert grams to kilograms:
Remember: 1 kilogram = 1000 grams
Calculation: 600 grams ÷ 1000 grams/kilogram = _____ kilograms.

2. Convert kilograms to pounds:
Remember: Your computer changes kilograms to pounds.
Calculation: The number of kilograms from your answer above is still on the screen. Press KILOGRAMS TO POUNDS KG/LB key to get _____ pounds.

3. Convert pounds to ounces
Remember: 1 pound = 16 ounces
Calculation: Number of pounds on screen × 16 ounces/pound = _____ ounces.

You're getting great! Here are BIGGER and better numbers to calculate!

Your computer can calculate with large numbers that are up to 7 digits long on the first line and second line. Let's try an example. Press CALCULATOR MODE. Now enter the following number:
2,340,567

That number is two million, three hundred forty thousand, five hundred sixty-seven. You may be used to seeing large numbers written with commas (2,340,567) but commas are not used for calculation.

Now, can you add 3 hundred twenty thousand?

1. Press the addition + key. **2.** Enter the following number: **320,000.** (Did you enter the right number of zeros?)
3. Press the equal = key. Your answer should read: **2,660,567.**

You can also calculate with small numbers that are up to 7 digits **small.**

Let's try an example. Be sure to CLEAR the screen.

1. Enter the following number: **0.003465**
   That number is three thousand, four hundred, sixty-five millionths.
2. Multiply that number by five thousand, three hundred, eleven **(5,311).**
3. Press the multiply × key.
4. Then enter the following number: **5311**
5. Press equal = key. Your answer is: **18.402615**

Depending how accurate you want to be, that answer is:

- about eighteen
- a little less than eighteen and a half.
- slightly more than eighteen and forty hundredths.
- eighteen and four hundred thousandths.
- eighteen and four hundred twenty six ten thousandths.
- (rounding the last digit) eighteen and forty thousand, two hundred sixty two hundred-thousandths.
- eighteen and four hundred two thousand, six hundred fifteen millionths.

Of course, no one would want to name a number that long. It's so much easier just to say "eighteen point four zero two six one five." That way, it's not much different than a phone number.

WHAT IS MATHQUIZ?

MATHQUIZ gives you problems in math to answer. After giving 10 problems, it then tells you how many answers you got right when you finished. You choose HOW DIFFICULT you want your Mathquiz to be—easy, medium or hard. YOU choose WHAT KIND OF PROBLEMS you want—addition, subtraction, multiplication, division, or any combination of the four.

You can also pick a number for a "Flash Card" type of quiz. For example: Say you wanted to do the multiplication table for 5, on easy level. The computer will choose easy one digit problems with 5 for you, like 8×5, 3×5, 4×5, and so on. (See page 45 and 46 for more explanation.)

Any time you press the MATHQUIZ key (even if you are in CALCULATOR Mode), you will hear a MUSICAL TUNE and see the title MATHQUIZ on the screen.

This will change to the question **LEVEL?** and you will hear TWO MUSICAL NOTES.

HOW HARD WILL YOUR QUIZ BE

There are three levels of difficulty—

EASY, MEDIUM AND HARD

EASY uses only 1-digit numbers (like 4) in the problems. Your answers will always be positive numbers. Depending on the operation you choose, you will see problems like the following:

9	7	5	16
+8	−4	×5	÷2 (see special division rules, pg. 41)

MEDIUM uses 2-digit numbers (like 32) as the first number in a problem and 1-digit numbers as the second number. Answers are always positive numbers. Depending on the operation you choose, you will see problems like the following:

37	82	11	72	
+6	−9	×4	÷8	(See special division rules, below.)

HARD uses only 2-digit numbers in the problems and your answers may be either positive or negative numbers. Depending on the operation you choose, you will see problems like the following:

91	75	22	144	
+24	−44	×56	÷12	(See special division rules, below.)

DIVISION IS A LITTLE DIFFERENT!

Division problems have their own rules, when it comes to level of difficulty.

EASY DIVISION problems are 1- **or** 2-digit numbers divided by 1-digit numbers. (Example: 45 ÷ 9)

MEDIUM DIVISION problems are 2- **or** 3-digit numbers divided by 1-digit numbers. (Example: 120 ÷ 5)

HARD DIVISION problems are 3- **or** 4-digit numbers divided by 2-digit numbers. (Example: 1540 ÷ 22) You may need your own paper and pencil for these problems.

SELECT YOUR LEVEL. When you see the question **LEVEL?** on the screen, press either the EASY, MEDIUM, or HARD key. The level you pick will show on the screen like this:

You will then hear SEVERAL MUSICAL NOTES and the screen will change to ask **PROBLEM?** This tells you to select the KIND OF PROBLEMS you want in your math quiz.

CHOOSE THE KIND OF PROBLEMS YOU WANT!

Press **any or all** of the yellow function keys: +, −, × and ÷. If you pick more than one kind of problem, the computer will mix them up.

When you press a function key, say +, the symbol + will appear at the right side of the screen and move to the center. Wait until it stops moving if you want to press another function key, or the second key won't work. After you've pressed all the function keys you want, press ENTER key. If you forget to press a function key before ENTER, you will hear a WARNING BUZZ.

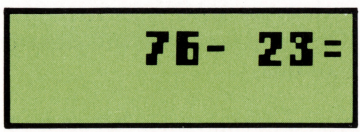
CHANGE YOUR MIND?

If you change your mind about any functions BEFORE you press ENTER, simply press the **CLEAR** KEY. Everything on the bottom line will move off the screen, leaving it clear for your new choices.

After you press ENTER, the only way you can change your mind is to press the MATHQUIZ key and go back to the beginning.

GETTING TO THE PROBLEMS

After you press ENTER, you will hear a THINKING TUNE. The screen will clear and your first MATHQUIZ problem will appear, like this example:

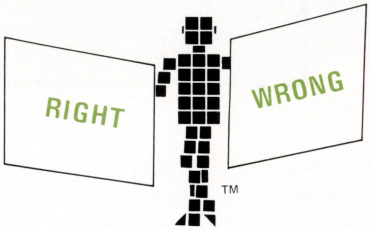


To answer the problem, press the NUMBER KEYS for the correct answer.

If your answer is a 2- or 3-digit number, press the farthest **left** digit first, just as you would say the number.

EXAMPLE: The answer to the problem shown on page 42 is 53. Press the 5 first, then the 3. Then press ENTER.

If you change your mind about an answer BEFORE you press ENTER, simply press the CLEAR key. CLEAR Your answer will disappear from the bottom line. Now press the new number keys you want, then ENTER.



ANSWERS

After you press ENTER the computer will tell you if your answer is right or wrong.

IF YOUR ANSWER IS RIGHT, you will hear FOUR RISING NOTES, THEN THE THINKING TUNE, THEN TWO RISING NOTES. The screen will clear and your next problem will appear

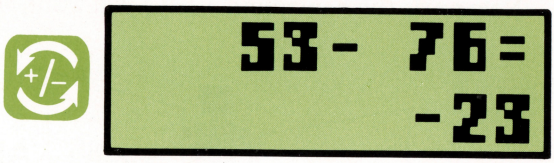
IF YOUR ANSWER IS WRONG, you will hear a LONG, LOW TONE, THEN TWO RISING NOTES. Your answer will disappear, but the problem will stay on the screen. Try another answer. The computer will let you try as many times as you like. It will not count against you. You can't go on to a new problem till you get correct answers or press TELL ME key.

TELL ME KEY

If you're stumped on a particular problem, don't worry. You can find out the answer by pressing the TELL ME key. The answer will appear below the problem and you will hear the THINKING TUNE, THEN TWO RISING NOTES. A TELL ME answer counts as an incorrect answer on your final score.

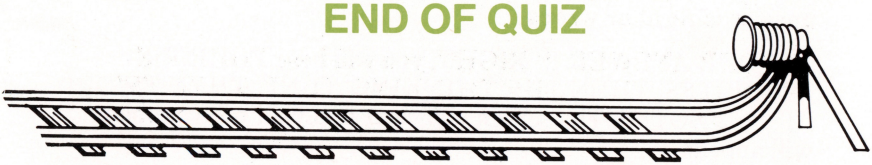
NEGATIVE! ANSWERS

If you run into a problem that has a negative answer (**example:** 53-76), press the +/- key after you press the NUMBER KEYS for your answer

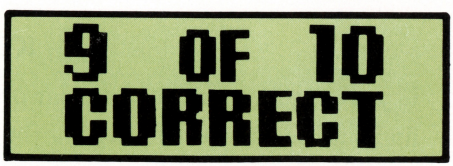


When the next problem appears on the screen, the computer will automatically go back to positive numbers. You will need to press the +/- key **each** time you have a negative answer, even if you have two negative answers in a row.

END OF QUIZ



When you have completed all ten problems in a quiz (after you press ENTER on the 10th problem), you will hear a MUSICAL TUNE and see your final score.



GO ON TO THE NEXT MATHQUIZ GAME

After your total score prints out, it remains on the screen for a couple of seconds, then changes to the question:

Press the YES or the NO key.

If you press YES, you will get the SAME LEVEL and the SAME KIND OF PROBLEMS, but the problems themselves will be different.

If you press NO, Cursor the Great™ will erase the screen and the computer will ask you to choose a **level of difficulty,** then the **kind of problems** you want again. Go back to pages 40 through 43, if you need a reminder on how to do this.

If you want to switch MODES (to CALCULATOR), you do not have to press NO. Just press the CALCULATOR key.

HOW TO SET UP FLASH CARD QUIZ

You can set up a "Flash Card" quiz to practice your numbers. One of the numbers in every problem will stay the same (will be constant):

Example: 4 + 3, 15 × 3, 6 ÷ 3, 7 − 3.

FLASH CARD QUIZ—

1. Press FUNCTION key. Example: − ÷ × +
You may choose one, two, three or all four functions. If you choose more than one, the computer will mix them up for you.

2. Press NUMBER key for the number you want repeated. (Example: all multiplication with 7 : 1 × 7, 4 × 7, 10 × 7, and so on).

3. Press a FUNCTION key if you decide to add another function after you press your "Flash Card" number. The symbol will appear in front of your number with the other functions.

4. Press **ENTER** key once.

If you picked EASY or MEDIUM LEVEL, your "Flash Card" number must be a 1-digit number. On HARD LEVEL, your "Flash Card" number can be 1- or 2-digit numbers. If you press 3 digits on Hard Level, the third digit you press will replace the second digit you pressed, the second digit will replace the first digit, and the first digit will be moved off the screen.
Example: If you start with 23, then press a 4, the screen will show 34.

WHEN YOU'VE PICKED THE KIND OF PROBLEMS YOU WANT...

Press the ENTER key. You only have to press it once, after you've pressed all the function keys you want...and a "Flash Card" number.

If you change your mind BEFORE you press ENTER, press the CLEAR key. Everything on the bottom line will move off the screen, leaving it clear for your new choices.

EXTRA NOTES ABOUT MATHQUIZ AND FLASH CARDS

1. FLASH CARDS—If you choose EASY LEVEL, some of the problems may appear more than once. This will be more likely to happen if you only pick one function for your Flash Card Quiz (like +).

2. MATHQUIZ—Once you have started a quiz, you cannot change levels, until you finish it. If a quiz turns out to be too difficult or too easy, press the MATHQUIZ key. This will stop the quiz and take you back to the beginning of the mode.

3. MATHQUIZ—None of the problems in Mathquiz, on any level, require decimal answers.

"HOW ARE YOU DOING?"

A QUICK REVIEW OF THE STEPS IN MATHQUIZ

1. Press MATHQUIZ key.

2. Press one of the LEVEL keys—EASY, MEDIUM or HARD.

3. Pick the kind of problems you want. Press ANY OR ALL of the yellow function keys: + , − , × , ÷

Press a 1- or 2-digit "Flash Card" number if you want a "Flash Card" quiz.

4.

Press ENTER key. (Use CLEAR key **before ENTER** if you change your mind about anything in Step 3.) If you want to change anything **after** you press ENTER, use the MATHQUIZ key to take you back to the beginning.

5. **To answer a problem,** press the NUMBER keys for the correct answer. If the answer is more than one digit, press the farthest **left** digit first. (Example: If your answer is 523, press the 5, then the 2, then the 3.)

6. Press ENTER key.

7. If you get stuck on a problem and want to know the answer, press the TELL ME key. You will see the correct answer, but the problem will count as INCORRECT on your final score.

8. All quizzes have 10 problems. At the end of a quiz, your final score will automatically show on the screen.

9.

Use the YES or NO key to answer the **SAME GAME?** question at the end of a quiz.

YES gives you the same level and kind of problems, but different problems.

NO takes you back to the beginning, to select level and kind of problems all over again.

AN INTERESTING FACT! YOU

This is an example of probability. Do you remember the meaning of the word from the section "SOME MATHEMATICAL WORDS TO KNOW," page 10?

No matter how many times you use the computer to give you a quiz, the quiz will almost always be different. That's because the computer has been programmed to mix the numbers it selects to give you.

The chance of your computer selecting any particular number out of the 10 possible numbers from 0 to 9 is 1 chance out of 10. What's more, over a large number of selections, each number will be selected about an equal number of times. So if your computer selects 100 numbers, each number should be selected **about** 10 times.

You might have fun checking this. Set the computer for MATHQUIZ, EASY LEVEL, and choose one operation (say +). Then keep track of what numbers the computer selects for the problems. You might want to use a table like this:

Numbers selected:

0	1	2	3	4	5	6	7	8	9	
////	//	////	///	//	//	~~////~~	///	///	////	(out of 32 total numbers)
~~////~~	~~////~~	~~////~~	~~////~~	~~////~~	~~////~~	~~////~~	~~////~~	~~////~~	~~////~~	(out of 100 total numbers)
///	~~////~~	~~////~~	~~////~~	~~////~~	~~////~~	////	~~////~~	~~////~~	~~////~~	
				//	/					

In the table "/" indicates one appearance of that number. Four slashes with a line through them; "~~////~~" shows five appearances.

The more total numbers you check, the more nearly equal will be the number of times each number from 0-9 occurs.

AIM FOR TARGET 0!

This is a game for two or more players, but one player can have fun practicing alone.

CAN COUNT ON PROBABILITY!

GAME I—EASY TARGET 0!

Set the computer to MATHQUIZ for multiplication problems at the MEDIUM level. Do the problems by yourself or with a friend, and write the answers down on a piece of paper after you do each problem. This list of ten answers will be the numbers you use to play "Target 0".

To play the game, set the computer in CALCULATOR MODE and enter the first of the ten answers on the screen. You and your friend now take turns subtracting numbers from that number until someone reaches the target number of 0.

However, you are only allowed to subtract numbers that have all digits alike. For example, you can subtract 33, 55, 99 or 777, but you can't subtract 34, 56, 96, or 788.

If, as a result of your turn, you create a negative number on the screen, you lose that round of the game.

Here's a sample round from a game, with two possible ways it might be played.

The number is	288		288
Fred's turn	−222	Fred	−111
	66		177
Sue's turn	−66	Sue	− 77
Sue wins!	0		100
		Fred	− 44
			56
		Sue	− 55
			1
		Fred	− 1
		Fred wins!	0

Play the game with all ten answers. The person who wins the most rounds is the winner.

GAME 2—HARD TARGET 0!

Set the computer in MATHQUIZ for multiplication problems at the HARD level. Follow the same directions as in GAME 1—EASY TARGET 0, to get the ten answers to use in this game.

Once again, you are allowed to subtract only numbers with identical digits. But this time, the digits you select must appear in the number on the screen. So, if your first number is 7341, you could subtract only numbers with digits of 7, 3, 4 or 1 (777 or 3333 or 44 or 111 would all be fine).

Example:

$$\begin{array}{r} 7341 \\ -777 \\ \hline 6564 \end{array}$$

Then you can only use numbers with digits of 6, 5 or 4 (66, 555, 444, etc.). Continue this way.

If, as a result of your turn, you create a negative number on the screen, you lose that round of the game.

Here's a sample round from a game, with two possible ways it might be played:

The number is	**1848**			**1848**
Fred's turn	**−1111**			**− 888**
	737			**960**
Sue's turn	**− 77**			**− 666**
	660			**294**
Fred's turn	**− 66**			**− 222**
	594			**72**
Sue's turn	**− 555**			**− 22**
	39			**50**
Fred's turn	**− 33**			**− 5**
	6			**45**
Sue's turn	**− 6**			**− 44**
Sue wins!	**0**			**1**
			Fred's turn	**− 1**
			Fred wins!	**0**

Play the game with all ten answers. The person who wins the most rounds of the ten played is the winner.

"31" IT'S FUN!

BEGINNERS' GAME

Before you play Advanced "31," practice with the following beginners' game:

Set the computer in **MATHQUIZ** for multiplication problems at the **MEDIUM** level. Do the problems by yourself or with a friend, and write the answers down on a piece of paper after you do each problem. This list of ten answers will be the numbers you use to play this game.

Both you and your opponent should each have a list of the same 10 answer numbers. Each of these numbers will have either two or three digits. For example, the number 93 has two digits, 9 and 3. The number 252 has three digits, 2, 5 and 2. With each number on your list, you are going to try to use the digits of that number to create the largest possible new number. To do this, you can use the operations of addition or multiplication only once for each number. Your goal is to make the largest possible number each time.

Here are some examples:

NUMBER	LARGEST POSSIBLE	OTHER POSSIBLE
56	5 × 6 = 30	5 + 6 = 11
81	8 + 1 = 9	8 × 1 = 8
140	1 + 4 + 0 = 5	1 × 4 + 0 = 4
238	2 + 3 = 5; 5 × 8 = 40	2 + 8 = 10; 10 × 3 = 30

When both you and your opponent have finished doing this with all of your ten numbers, compare your results for each number. If a player has created a number that is larger than the other player's, a point is scored. The player with the most points is the winner.

IT'S FUN! ADVANCED GAME

Follow directions as in Beginner's "31" to get your ten answers for this game. Use either the MEDIUM or HARD level.

With your 10 answers ready, see if you can use all the digits of each number to arrive at the number 31 or as close to it as possible. You can use any of the four operations (addition, subtraction, multiplication, or division). But you can use each digit only once. You can use as many operations as you want to.

To keep score, you deduct points as follows:

1. If you make "31" without using all the digits in your number, then deduct the amount of the leftover digit.

   For example: the number is 3942
   If you did it this way,
   $3 \times 9 = 27; 27 + 4 = 31$
   you would lose 2 points because the digit 2 was left out.
   But if you did it this way,
   $4 \times 9 = 36; 36 - 3 = 33; 33 - 2 = 31$
   you would not lose any points because you used all four digits.

2. If you can't make 31, then you deduct the difference between what you can make and 31. You may be either higher or lower than 31.

   For example, the number is 7501
   If you did it this way,
   $7 \times 5 = 35; 35 - 1 = 34; 34 + 0 = 34$
   you would lose 3 points because 34 is three above 31.

If you did it this way,

$5 - 1 = 4; 4 \times 7 = 28; 28 + 0 = 28$

you would also lose 3 points because 28 is three below 31. But if you did it this way,

$7 - 1 = 6; 6 \times 5 = 30; 30 + 0 = 30$

you would lose only 1 point because 30 is one below 31.

3. The winner is the player with the fewest points deducted after having worked out all ten numbers.

Here are a few more examples with the scores for each:

	Score
The number is 2368	
$6 + 8 = 14; 14 \times 2 = 28; 28 + 3 = 31$	0
The number is 2400	
$2 \times 4 = 8; 8 + 0 = 8; 8 + 0 = 8$	23 (31 – 8)
The number is 2365	
$5 \times 6 = 30; 30 + 3 = 33; 33 - 2 = 31$	0
The number is 6474	
$4 \times 6 = 24; 24 + 7 = 31$	4 (digit left)
The number is 5628	
$5 + 6 = 11; 11 \times 2 = 22; 22 + 8 = 30$	1 (31 – 30)
The number is 1365	
$5 \times 6 = 30; 30 + 3 = 33; 33 - 1 = 32$	1 (32 – 31)
The number is 5994	
$5 \times 9 = 45; 45 - 9 = 36; 36 - 4 = 32$	1 (32 – 31)
The number is 825	
$5 \times 8 = 40; 40 - 2 = 38$	7 (38 – 31)
The number is 2530	
$3 \times 5 = 15; 15 \times 2 = 30; 30 + 0 = 30$	1 (31 – 30)
The number is 5742	
$7 \times 4 = 28; 28 + 5 = 33; 33 - 2 = 31$	0
Total score	38

THE CASE OF THE

Sometimes even the best tools break down. Airplane pilots go through extensive training so that they know what to do if a system breaks down on their plane. On today's carefully designed planes, there is almost always a backup system that can be used.

Let's suppose your calculator were to have a breakdown. Pretend that the only number keys that work are "1" and "0." All function keys work fine.

Using only the working keys, can you enter the number "13" on the screen?

One way to do it would be to add "1" 13 times:

1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 = 13

A quicker, shorter way would be:

10 + 1 + 1 + 1 = 13

Get the idea? Well, that one was easy enough.

Now can you enter "56" on the screen? Remember only 1 and 0 work.

Of course, you could add "1" 56 times.

Or you could do this:

10 + 10 + 10 + 10 + 10 + 1 + 1 + 1 + 1 + 1 + 1 = 56

Or you could do this:

1 + 1 + 1 + 1 + 1 × 10 + 1 + 1 + 1 + 1 + 1 + 1 = 56

Or you could do this:

11 + 11 + 11 + 11 + 11 + 1 = 56

Or you could do this:

1 + 1 + 1 + 1 + 1 × 11 + 1 = 56

Not too hard, was it? You can see there are several ways to get to the same place.

BROKEN CALCULATOR!

Now try entering "142" on the screen. Yes, you can enter "1" 142 times! And you can enter "10" 14 times and "1" twice.

But how about this:

$$100 + 10 + 10 + 10 + 10 + 1 + 1 = 142$$

Or this:

$$10 \times 11 + 10 + 10 + 10 + 1 + 1 = 142$$

You can even add and subtract with your pretend-broken-down calculator. Using only the working keys, try these problems:

$$\begin{array}{r} 43 \\ +38 \\ \hline \end{array} \qquad \begin{array}{r} 23 \\ -17 \\ \hline \end{array}$$

One way of doing the addition problem would be:

$$\begin{array}{l} 10 + 10 + 10 + 10 + 1 + 1 + 1 = 43 \\ +10 + 10 + 10 \qquad + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 = 81 \end{array}$$

One way of doing the subtraction problem would be:

$$\begin{array}{l} 10 + 10 + 1 + 1 + 1 = 23 \\ -10 \qquad - 1 - 1 - 1 - 1 - 1 - 1 - 1 = 6 \end{array}$$

Now here are a few problems for you to try. Play with a friend. Each player tries the same number. The person with the shortest way of writing that number wins. When you have tried the numbers suggested below, you can play the game by taking turns suggesting a number for both players to enter.

Enter the following numbers on the screen. (Remember: You're still pretending that the only working keys are 1 and 0.)

333	753	998
668	425	878

Some possible solutions are in the answer section on page 67.

Now make up numbers of your own to try. Or make up some addition or subtraction problems.

OH, OH! ANOTHER KIND OF CALCULATOR BREAKDOWN!

This time, pretend that the only number keys that work are "5," "6," "8," and "9." All function keys work.

Using only the working keys, can you enter the following numbers on the screen? You can add, subtract, multiply or divide with the computer.

300	427	834
600	0.5	223

Here's one example:

If the goal is 743:

88 × 8 = 704; 704 + 56 = 760; 760 - 8 = 752; 752 - 9 = 743

That took four operations. Can you discover a solution that requires fewer operations?

Play with a friend. Each player takes the same target number and tries to find how to get there with the fewest operations.

In this game there is no "wrong" answer. But the rules of the game say the best answer is the shortest answer.

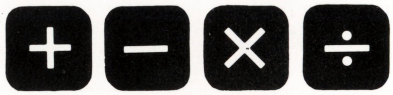
Some solutions are given in the answer section on page 68.

Try making up your own target numbers. Is there any number that is particularly difficult to do? Is there any number that is impossible to do? What numbers are very easy?

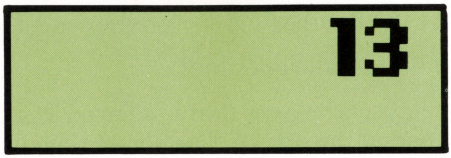
CAN YOU BEAT ANOTHER BREAKDOWN PROBLEM?

Now pretend you can use only the number

and the four function keys.



Can you make the screen read 13?

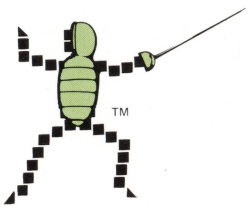


How about 60 in only 3 operations?

Use only the number 8.
Can you make the screen read 1000?
Use only the number 1.
Can you make the screen read 100?
Use only the numbers 1 and 0.
Can you make the screen read 4738?

Remember in all of these problems you are trying to find not just one way, but the shortest way.

Some solutions are given in the answer section on page 68.



CHALLENGE: Can you make up some interesting broken calculator problems of your own? Try them out on a friend.

This is a variation on an old game called "NIM" to play with a friend. It has a secret method for winning you'll soon figure out!

Set the computer in CALCULATOR MODE.

Enter the number **"21"** on the screen.

Now decide who goes first.

The player who goes first is allowed to subtract 1, 2 or 3 from the number on the screen. The player then presses the = sign to see what number is left.

The second player now does the same thing, subtracting 1, 2 or 3.

Play continues in this way, first one person, then the other, until 0 is reached. The person who is able to make the subtraction move that produces a 0 on the screen is the winner!

Something to think about: There is a way to be sure that you can always win. Here's a hint: The person who goes first has a real advantage. Once you've figured out how to win every time, you can amaze your friends with your cleverness. (the secret is on page 69.)

TRY NIM ANOTHER WAY

Enter the number **"31"** on the screen.

Decide who goes first.

In this game each player is allowed to subtract 1, 2, 3 or 4 from the number on the screen.

Play is the same as in the first game you learned. Again, the player who is able to make the subtraction move that produces a 0 on the screen is the winner!

Something to think about: Can you discover how to win this game every time? (See the answer on page 69 if you can't figure it out.)

- **Can you make up your own variation of "NIM"?**

  Here's how:

  Pick a number you would like to start with.

  Decide what numbers you will allow to be subtracted from that number.

  Play with a friend and see if you can win.

  Something to think about: Can you make a "NIM" game that you will always be able to win?

- **Here's one more way to play:**

  Set the computer in MATHQUIZ. Program your computer for multiplication problems at the EASY level. Write down the first problem where the answer is greater than 21. Now play "NIM" in the following way:

  First add 1 to the answer. This is the starting number for the "NIM" game.

  Now pick one of the two numbers that were multiplied. (These are called the factors.) Subtract 1 from this number. The numbers you will be allowed to subtract in your "NIM" game will be the numbers from 1 up to this number.

  Here's an example:

$$\begin{array}{r} 8 \\ \times\ 7 \\ \hline 56 \end{array}$$

Starting number for game is 56 + 1 = 57. One of the factors is 7. Subtracting 1 from 7 = 6. Numbers that can be subtracted in the game are 1, 2, 3, 4, 5, 6. Now set the computer in CALCULATE MODE and play this new game.

Something to think about: Do you know how to win every time?

ARE YOU GAME FOR THE AGE GAME?

Yes! You'll amaze your friends with this game, too. Any age can play!

The Age Game is very easy, particularly when you have your computer to help.

Just follow the instructions. If you do all the calculations correctly, your age will still be the same at the end.

Write your age, right now			_____
Add your age on your next birthday	+	_____	= _____
Add 23	+	23	= _____
Subtract your age, right now	−	_____	= _____
Subtract 28	−	28	= _____
Multiply by 5	×	5	= _____
Divide by 10	÷	10	= _____
Multiply by 8	×	8	= _____
Divide by 4	÷	4	= _____
Subtract 17	−	17	= _____
Add 21	+	21	= _____

The last number should be your age again.

Now that you've tried it on your own age, try it on a friend's age or on your Mother's age or on your Father's age.

Challenge: Can you figure out why this game will work for any age? Can you make up a game of your own that will work the same way for any age?

One of the advantages of the computer is that you can work out problems that have large numbers. These problems are often difficult to do accurately without a calculator, even for good mathematicians, because when there are a lot of calculations to do, there's

always a chance for an error. Your computer can help you do calculations with large numbers accurately.

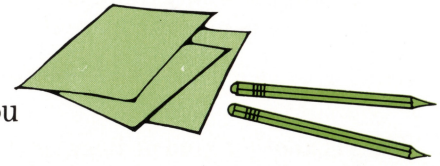
THE BIGGER THE BOGGLER™

THE BETTER IT IS!

A Boggler is a problem that doesn't make a lot of sense, but is fun to do. It is even more fun to make one up and give it to a friend to do. There is no right answer for a Boggler; the challenge is to see if you can get an answer!

A Boggler requires that you supply the information requested and then do the calculations indicated. You may also have to do some other things you have learned in this book, like converting from U.S. to metric measurements.

Here is a Boggler that is about you. (You may need pencil and paper to help you keep track as you work it out.)



Enter how old you are in months. _____

Add the sum of the digits of the number of the year in which you were born. + _____ = _____

Subtract the sum of the digits of your phone number (including area code). − _____ = _____

Add your weight in kilograms + _____ = _____

Subtract your height in centimeters − _____ = _____

Multiply by the number of children in your family (don't forget yourself). × ___ = ___

Divide by the day of the month of your birthday (round to the nearest whole number). ÷ ___ = ___

Add the number of meters you can walk in one minute. + ___ = ___

Subtract how high you can jump in centimeters. − ___ = ___

Divide by how old you will be in the year 2000 (round to the nearest whole number). ÷ ___ = ___

Add the sum of the digits of your zip code. + ___ = ___

Subtract the number of teeth you now have (new teeth count if you can see them). − ___ = ___

Multiply by the total number of people directly related to you, but not in your immediate family (for example, aunts, uncles, cousins, grandparents). × ___ = ___

Final Answer ___

Here is another kind of Boggler. To do this one, you will probably need an Almanac or some other sources of information. Give it a try. Why not make one up like this for a friend or for your parents?

Write the number of home runs that have been hit by the leading home run hitter in the major leagues as of this date (if it is not baseball season, use information from last season). ___

The January 30, 1977 episode of "Roots" was watched by more people than any other TV program to date. Add about how many million people watched. + ___ = ___

The cheetah is thought to be the fastest animal in the world. Add his speed in kilometers/hour. + ___ = ___

Man is not so fast. Subtract the approximate maximum speed of a human being in kilometers/hour. − ___ = ___

The Coast Redwood tree of California is considered the tallest tree in the world. Add its approximate height in meters. + ___ = ___

Subtract the number of days of the longest manned trip into space. − ___ = ___

Divide by the approximate number of telephones in millions in New York City (round to nearest whole number). ÷ ___ = ___

In 1972, Dave Wottle of the United States finished first in the 800 meter run in the Olympic games. Add the number of seconds it took him to run that far. + ___ = ___

In 1972, Melissa Belotte of the United States finished first in the 100 meter backstroke in the Olympic games. Subtract the number of seconds it took her to swim that far. − ___ = ___

In Eastport, Maine, the ocean tides rise and fall a greater distance than anywhere else in this country. Divide by about how far the tides rise and fall in meters (round to the nearest whole number). ÷ ___ = ___

Multiply by the sum of the digits of the year in which Halley's Comet is expected to return to the vicinity of earth. + ___ = ___

Add the number of kilometers in thousands from the earth to the moon. + ___ = ___

Divide by the number of people who have been President of the United States (round the nearest whole number). ÷ ___ = ___

Add the number of meters that Death Valley is below sea level. + ___ = ___

Final Answer ___

ANSWERS!!!

THINK METRIC! IT MAKES SENSE!

Answers for page 31

Volume	Gallons	Liters
	1	3.7850114
	5	18.925057
	10	37.850114
	25	94.625284
	50	189.25057
	100	378.50114

	Liters	Gallons
	1	0.2642
	5	1.321
	10	2.642
	25	6.605
	50	13.21
	100	26.42

Length	Feet	Meters
	1	0.3048
	5	1.524
	10	3.048
	25	7.62
	50	15.24
	100	30.48

	Meters	Feet
	1	3.2808399
	5	16.404199
	10	32.808399
	25	82.020997
	50	164.04199
	100	328.08399

Weight	Pounds	Kilograms
	1	0.4536
	5	2.268
	10	4.536
	25	11.34
	50	22.68
	100	45.36

Kilograms	Pounds
1	2.2045855
5	11.022928
10	22.045855
25	55.114638
50	110.22928
100	220.45855

THE CASE OF THE BROKEN CALCULATOR!

Answers for page 56 & 57.

$1 + 1 + 1 \times 111 = 333$
$1 + 1 + 1 + 1 + 1 + 1 \times 111 + 1 + 1 = 668$
$10 - 1 - 1 - 1 \times 110 - 10 - 10 + 1 + 1 + 1 = 753$
$1 + 1 + 1 + 1 \times 100 + 11 + 11 + 1 + 1 + 1 = 425$
$10 - 1 \times 111 - 1 = 998$
$10 - 1 - 1 \times 110 - 1 - 1 = 878$

(Note: There are many possible ways of doing each of the above problems. Your way may be just fine if it gets to the same number without taking too long to do so.)

OH, OH! ANOTHER KIND OF CALCULATOR BREAKDOWN!

Answer for pages 58 and 59.

5 × 9 = 45; 45 + 5 = 50; 50 × 6 = 300

9 × 85 = 765; 765 - 65 = 700

6 × 8 = 48; 48 × 9 = 432; 432 - 5 = 427

6 × 8 = 48; 48 ÷ 96 = 0.5

88 × 9 = 792· 792 + 56 = 848; 848 - 8 = 840; 840 - 6 = 834

55 × 5 = 275; 275 - 65 = 210; 210 + 8 = 218; 218 + 5 = 223

(Note: There may be shorter ways of doing these, or other ways that are of equal length.)

4 ÷ 4 = 1; 1 + 4 + 4 + 4 = 13

44 ÷ 4 = 11; 11 + 4 = 15; 15 × 4 = 60

888 ÷ 8 = 111; 111 - 8 = 103; 103 × 8 = 824;
824 + 88 = 912; 912 + 88 = 1000

111 - 11 = 100

(Note: There may be shorter ways of doing these, or other ways that are of equal length.)

NIM SKILL!

Answers for pages 60 and 61.

When the beginning number is 21.

If you go first, you can always win.

First you subtract "1."

Then, each time it is your turn you choose the number to subtract so that the balance that remains after your turn is 16, 12, 8, 4, and finally 0.

Whatever your opponent chooses to subtract, you can always subtract the right amount that will allow you to win.

Another way of thinking about it is that after you choose "1" to start, you then subtract the number which if added to your opponent's number would equal "4." So, if your opponent chooses "3," you choose "1." If your opponent chooses "2," you choose "2." And if your opponent chooses "1," you choose "3."

When the number is 31:

As before, you go first by subtracting 1.

From then on you make the balance equal 25, 20, 15, 10, 5, and 0.

Or, in other words, you choose the number which if added to your opponent's number would equal 5.

If the number were 50:

The number you would allow to be subtracted would be 1, 2, 3, 4, 5, 6.

To win you would start by subtracting "1" and then the number which when added to your opponent's number would equal 7.

Your target numbers would thus be: 42, 35, 28, 31, 14, 7, and 0.

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